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Fixing Bad Wiring

Self-repair technologies and new regulations bloom from FAA-sponsored research

JAMES OTT/DAYTON, OHIO

Increased inspections of wire bundles in airliners that resulted in recent flight cancellations are an outgrowth of more than a decade's worth of FAA research into the safe transmission of electrical power and new technology developments such as self-repairing wire.

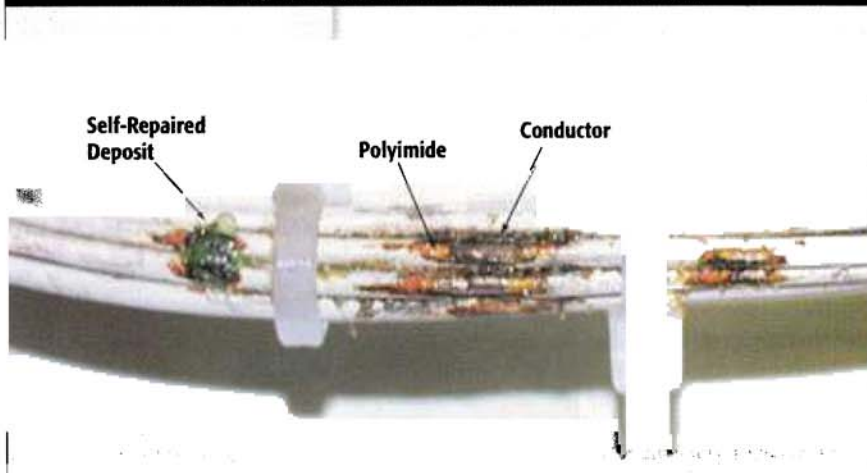
This work has led to stricter regulations for airlines to maintain and inspect wires. The FAA offers a variety of technologies that can be used to meet the new obligations. Hardware from the research includes innovative circuit breakers, connectors and wiring bundle clamps and new methods to mitigate potential hazards.

The FAA has designed a set of tools for carriers to assess risks of operating older aircraft. In the aging process, wiring becomes vulnerable to insulation cracking and chafing, which can lead to electrical shorts and a fire hazard. A risk assessment model is available through the William J. Hughes Technical Center near Atlantic City, N.J., where a wiring testbed is offered to airlines without cost.

"No one technology solves all problems," says Michael Walz, the FAA's aircraft electrical systems program manager for research and development at the Hughes center. "We've done ex-

AIRCRAFT WIRING BUNDLE WITH DAMAGED AND SELF-REPAIRED INSULATION

(Test Self-Repair Solution on Wire Bundle: 115Vac, 20A or 27Vdc, 1A)

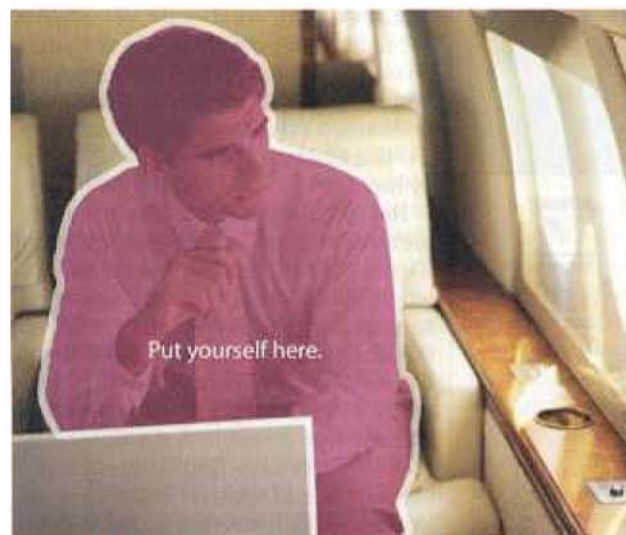


Repair to an exposed and positively charged wire appears as a green cover on the wire after application of a polyvinyl alcohol spray from a hand-held device. Polyimide is the material used for insulating wire.

tensive research into how wires fail and the reasons why they fail, and we have gotten beyond that into tough insulation, self-healing wires and repair techniques."

A key researcher in self-repairing

wire, Robert E. Kauffman, is launching the application as a commercial enterprise. A chemist and fluids analyst at the University of Dayton Research Institute (UDRI), Kauffman has applied for a patent on a spray of nontoxic polyvinyl alco-



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hol that can be applied to bare wires in a frayed bundle as a temporary fix or as a preventative coating on wiring at the point of manufacture. Kauffman devised the concept under an FAA grant totaling \$1.3 million, \$240,000 of which was for self-repairing wire studies.

The latest grant through 2008 also allows Kauffman and his team to explore whether the use of a listening device planted near runways—or anywhere between landing points and the gate—could pick up radio-frequency signals from wet, exposed conductors in aircraft and help mechanics locate problem areas.

Kauffman has decided on the commercial course, where he expects the fix will be more easily accepted for household and industrial uses, which may enhance its chances for adoption later by aviation.

The FAA has not approved the self-healing wire for aviation, saying that more research is required. "It is necessary to understand the long-term ramifications of the material and to ensure the treated wire is as stable as the original installation," according to officials at the agency's transport directorate.

In its response, the FAA further said

UDRI envisions the self-healing wire treatment as a repair to wire breaches that would allow an aircraft to travel safely to a maintenance facility for a permanent repair. Research will focus on arc and abrasion testing of a pre-treated wire to be produced by a manufacturer.

Aging wiring has been under intense study since the loss of TWA Flight 800 in 1996

"Once approved for aviation use, this technology, along with other developments such as arc fault devices, may provide additional protection against faults in aircraft wiring," the agency said.

Aging wiring has been under intense study since the center wing tank explosion that caused the 1996 loss of TWA Flight 800. Kauffman was one of the original researchers and part of a team from the

university and SRI International. They concluded that fuel tank residues that form near low-sulfur jet fuel, water and silver-coated surfaces are conductive and can ignite fuel if exposed to electrical power even as low as a radio battery output. But the NTSB, based on available evidence, could not identify the energy-release mechanism or the location of the ignition.

In 1999, the FAA widened the study of electrical systems research with two programs co-sponsored by the Defense Dept.—a project with the Navy to develop an arc-fault circuit breaker and another with the Air Force for wire testing equipment. The agency's Aging Transport Systems Rulemaking Advisory Committee launched a review of wiring on recently retired aircraft.

The FAA has identified technologies and approaches airlines can adopt to inspect for wiring defects. These are presented on a spreadsheet on the FAA web site and include costs of each inspection. Last fall, the agency issued Advisory Circular AC 25-27 that described inspection and maintenance procedures, one of 12 ACs growing out of the Enhanced Airworthiness Program for Airplane Safety/Fuel Tank Safety Final Rule issued last November.

Since 2004, research has focused on proof-of-concept studies and how to mitigate and prevent hazards including self-repairing wire. Kauffman's research is one of two proof-of-concept studies. The other, a NASA program, proposed using a chemical additive to insulation that would repair a damaged area when heat was applied. The study showed some progress, but funding has been exhausted.

Waltz says the Boeing 787 is being equipped with solid-state versions of arc-fault circuit breakers. These contain an electronic board that seeks an arc signature and shuts down automatically if it finds one. It's a smart version of the electro-thermal circuit breaker, which trips by heat.

Research has focused on a wire bundle smart clamp. It sends a signal when it's not properly installed or when it no longer functions and could allow wires to sway and possibly be damaged. Waltz is leading studies into another preventative method called fault current management, which involves limiting electrical current on a power line, possibly using resistors. He says fault current management would apply to many pieces of avionics equipment that do not require strong currents. By limiting power on a line, "the most destructive power from arcs goes away."

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